REMARKS

Claims 1-7, 9-11, 14, 17, 18, 22, 23, 30, 32-35 and 41-58 are pending in this application. By this Amendment, the drawings are replaced pursuant to the attached drawing sheet, claims 8, 12, 13, 15, 16, 19-21, 24-29, 31 and 36-40 are cancelled without prejudice to or disclaimer of the subject matter contained therein, and the specification and claims 1, 6, 9-11, 14, 17, 18, 22, 33, 44-46, 50-52, 54 and 55 are amended. Claims 1, 44, 46, 51 and 52 are amended to include the features of claim 8. Claims 22, 50 and 54 are amended to recite features supported in the specification on page 31, lines 5-19. Claims 9, 10, 14 and 17 are amended to correct claim dependencies. No new matter is added by any of these amendments.

Applicants gratefully acknowledge that the Office Action indicates that claims 41-43 are allowed, and that claims 9, 10, 12 and 14 contain allowable subject matter. However, Applicants assert that claims 1-7, 9-11, 14, 17, 18, 22, 23, 30, 32-35 and 44-58 are allowable for the reasons discussed below.

Reconsideration based on the following remarks is respectfully requested.

I. Reference is Properly Disclosed

The Office Action asserts that "Linear and rotary encoders using electronic speckle correlation", *Optical Engineering*, v. 30, no. 12, ©Dec. 1991 by Yamaguchi *et al.* (hereinafter "Yamaguchi") was cited but not included in the February 14, 2001 Information Disclosure Statement. Yamaguchi was one of twenty references listed in the February 14, 2001 Form PTO-1449, and a copy all twenty were received by the Patent Office, as shown by the attached PTO-stamped receipt. However, Applicants enclose an additional copy of Yamaguchi for the convenience of the Examiner.

The Examiner is requested to initial Yamaguchi to acknowledge the fact that the Examiner has considered all the cited disclosed information, and return to the undersigned a

copy of the subject Form PTO-1449. For the convenience of the Examiner, a copy of that form is also attached.

II. The Drawings Satisfy All Formal Requirements

The Office Action objects to the drawings based on informalities. Figure 17 is replaced with the attached drawing sheet, which was revised as required by the Examiner. Withdrawal of the objection to the drawings is respectfully requested.

III. The Abstract Satisfies All Formal Requirements

The Office Action objects to the Abstract due to excessive length. The Abstract has been amended, as attached, to obviate the objection. Withdrawal of the objection to the Abstract is respectfully requested.

IV. The Specification Satisfies All Formal Requirements

The Office Action objects to the specification regarding selected reference identifications. The specification has been amended to obviate the objection. Withdrawal of the objection to the specification is respectfully requested.

V. The Claims Satisfy All Formal Requirements

The Office Action objects to claims 1, 7, 8, 10, 15, 16, 22, 24, 30, 33, 34, 40, 41, 50, 51, 54 and 55 based on informalities. Claims 8, 15, 16, 24 and 40 have been cancelled and claims 1, 7, 22, 30, 33, 50, 51, 54 and 55 have been amended to obviate the objection, in view of the Examiner's helpful comments. However, Applicants respectfully disagree with the Office Action assertion that "predictable systematic estimation errors" at lines 8-9 of claim 7 and line 7 of claim 30 lack antecedent basis. See line 4 of claims 7 and 30. Withdrawal of the claim objection is respectfully requested.

VI. The Claims Satisfy the Requirements under 35 U.S.C. §112, second paragraph

The Office Action rejects claims 8, 11, 13, 15, 18, 27 and 40 under 35 U.S.C. §112, second paragraph, as being indefinite. Claims 8, 13, 15, 27 and 40 have been cancelled, and claims 11 and 18 have been amended to obviate this rejection, in view of the Examiner's

helpful comments. Withdrawal of the rejection under 35 U.S.C. §112, second paragraph is respectfully requested.

VII. The Claims Define Patentable Subject Matter

The Office Action rejects claims 1-5, 15, 16, 18-29, 44, 46, 47, 50 and 52-56 under 35 U.S.C. §102(b) over Japanese Patent Application 07-129770 to Hirooka *et al.* (misidentified in the Office Action as 09-129770 and hereinafter referred to by Applicants as "Hirooka"). This rejection is rendered moot with respect to claims 15, 16, 19-21 and 24-29, and is respectfully traversed with respect to the remaining claims.

Hirooka does not teach or suggest a method for estimating a displacement of a second image acquired by a sensing device relative to a first image acquired by the sensing device, the method including determining a set of image-dependent correlation function value points indicative of a correlation function extremum, each image-dependent correlation function value point based at least partially on a pattern of image values included in both the first image and the second image, each image-dependent correlation function value point further based on a respective known spatial translation of the image values in the second image relative to the image values in the first image, and estimating at least one respective spatial translation position corresponding to at least one respective symmetry point based on a plurality of the image-dependent correlation function value points bounding the correlation function extremum, the at least one respective spatial translation position indicative of the displacement of the second image relative to the first image, wherein estimating the spatial translation position corresponding to the at least one respective symmetry point includes determining the midpoint of at least one line segment having a first endpoint that is one of image-dependent correlation function value point, and an estimated correlation function value point lying on the correlation function on a first side of the correlation function extremum, and a second endpoint that is one of an image-dependent function value point, and an estimated correlation function value point lying on the correlation function on the second side

of the correlation function extremum, as recited in claim 1, and similarly recited in claim 44 for a position determining system, claims 46 and 51 for position determining devices, and claim 52 for an information storage medium.

Also, Hirooka fails to teach or suggest a method for estimating a displacement of a second image acquired by a sensing device relative to a first image acquired by the sensing device, the method including determining a set of image-dependent correlation function value points indicative of a correlation function extremum, each image-dependent correlation function value point based at least partially on a pattern of image values included in both the first image and the second image, each image-dependent correlation function value point further based on a respective known spatial translation of the image values in the second image relative to the image values in the first image, and estimating at least one respective spatial translation position corresponding to at least one respective symmetry point based on a plurality of the image-dependent correlation function value points bounding the correlation function extremum, the at least one respective spatial translation position indicative of the displacement of the second image relative to the first image, wherein estimating the spatial translation position corresponding to the at least one respective symmetry point including determining a first line including two image-dependent correlation function value points lying on the correlation function on a first side of the correlation function extremum, determining a second line having a slope that is the negative of the slope of the first line and that includes an image-dependent correlation function value point lying on the correlation function on a second side of the correlation function extremum and having a correlation function value in a range included within a range whose end points are the correlation function values of the two image-dependent correlation function value points included in the first line, and determining the spatial translation position corresponding to the intersection of the first and second lines, as recited in claim 22, and similarly recited in claim 50 for a position determining device, and claim 54 for an image storage medium.

Instead, Hirooka discloses an image processor for template images. In particular, Hirooka teaches the principle of peak presumption (or estimation) to produce a correlation value with the template image. Specifically, the peak is estimated from four neighboring points and a correlation value or for an energy search. See paragraphs [0091] – [0097] and [0105] and drawing 19 of Hirooka.

Applicants respectfully point out that Hirooka employs an interpolated estimate of a peak based on opposite slopes of values approaching the peak in a three-dimensional score map. However, these slopes are not in principle, nor in general, symmetric. The core of the search space is assumed to correspond to a peak core, and the correlation value in this peak core is compared to the correlation value in the shiftable and/or rotatable location.

In contrast, Applicants' independent claims are directed to estimating a displacement between images using a plurality of correlation function value points. Further, the claimed features employ a symmetry point for estimating a spatial translation position. The claimed features also exclude the correlation function value point that lies at a spatial offset bounded by other members of the plurality of correlation function value points, as recited in claims 23 and 53. There is no teaching or suggestion in Hirooka for any of these claimed features.

A claim must be literally disclosed for a proper rejection under §102(a), (b) and (e). This requirement is satisfied "only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." See MPEP §2131. Applicants assert that the Office Action fails to satisfy this requirement with Hirooka.

The Office Action further rejects claim 6 under 35 U.S.C. §103(a) over Hirooka in view of U.S. Patent 4,671,650 to Hirzel *et al.* (hereinafter "Hirzel"). The Office Action further rejects claims 7, 17 and 30 under 35 U.S.C. §103(a) over Hirooka in view of "Systematic errors in digital image correlation caused by intensity interpolation", *Optical Engineering*, v. 39, no. 11, ©Nov. 2000 by Schreier *et al.* (hereinafter "Schreier"). These rejections are respectfully traversed.

Hirzel does not compensate for the deficiencies of Hirooka outlined above for claim 1. Nor does Hirzel teach, disclose or suggest the additional features recited in claim 6. Instead, Hirzel discloses determination of an aircraft position and velocity. In particular, Hirzel teaches a camera 11 on an airplane 10 with front and rear sensors 12, 14 having corresponding CCD arrays 20, 24 to produce overlapping images of the earth's surface processed by a computer 45. Hirzel further teaches correlating the overlapping images by comparing the value sums to identify the greatest sum. Hirzel also teaches correlation methods by differencing and by relative image position shifting. See col. 4, lines 32-37, col. 5, lines 12-16, col. 12, lines 3-5, 44-52, col. 19, lines 48-53, col. 20, lines 20-25 and Figs. 1, 2 and 7a-7c of Hirzel.

Schreier does not compensate for the deficiencies of Hirooka outlined above for claims 1 and 22. Nor does Schreier teach, disclose or suggest the additional features recited in claims 7, 17 and 30. Instead, Schreier teaches reduction of interpolation errors in digital image correlation. In particular, Schreier teaches an iterative correlation algorithm to produce a cross-correlation coefficient using second order polynomials. See page 2917 col. (a), lines 4-27 of Schreier.

Further, there is no motivation to combine features related to the airplane positioning determiner of Hirzel or the iterative cross-correlation coefficient of Schreier with the image processor of Hirooka, nor has the Office Action established sufficient motivation or a *prima facie* case of obviousness. Even assuming that motivation to combine the applied references is established, the combinations fail to teach or suggest Applicants' claimed features.

A *prima facie* case of obviousness for a §103 rejection requires satisfaction of three basic criteria: there must be some suggestion or motivation either in the references or knowledge generally available to modify the references or combine reference teachings, a reasonable expectation of success, and the references must teach or suggest all the claim

limitations. See MPEP §706.02(j). Applicants assert that the Office Action fails to satisfy these requirements with Hirooka and Hirzel or Hirooka and Schreier.

For at least these reasons, Applicants respectfully assert that the independent claims are now patentable over the applied references the applied reference. The dependent claims are likewise patentable over the applied references for at least the reasons discussed as well as for the additional features they recite. Consequently, all the claims are in condition for allowance. Thus, Applicants respectfully request that the rejections under 35 U.S.C. §§102 and 103 be withdrawn.

VIII. Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully submit that this application is in condition for allowance. Favorable reconsideration and prompt allowance are earnestly solicited.

Should the Examiner believe that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,

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Registration No. 27,075

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JAO:GWT/gwt

Attachments:
Petition for Extension of Time
Amended Abstract
Replacement Drawing Sheet (Fig 17)
Copy of Yamaguchi reference
Copy of earlier filed PTO-1449
Copy of stamped receipt (February 14, 2001)

Date: September 10, 2004

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ABSTRACT OF THE DISCLOSURE

An image ~~which is determined by surface is captured and stored by sensing device. Subsequently, at a second image corresponding to a displacement of the surface is captured and stored. The two images are repeatedly compared at different offsets in a displacement direction. Theoretically, the most extreme value of the comparison will occur at the image offset that corresponds exactly with the actual displacement. However, typically none of the comparison offsets correspond exactly with the actual displacement, therefore interpolation between the~~ comparison ~~offsets is required. The~~ method ~~of comparing the images, as well as the~~ and an interpolation method ~~of interpolating to determining~~ determine the image offset corresponding to the extreme value of the comparison ~~can both~~ contributes to systematic errors in estimating the displacement of the surface from the images. ~~Herein, the~~ The systematic errors are rejected by correlation-based comparison systems and methods which reduce the curvature of the correlation function for offsets ~~which~~ that bound the extreme value, and by interpolation systems and methods ~~which~~ that are relatively insensitive to the asymmetry of the correlation function value points selected as the basis for the interpolation. These systems and methods allow fast, highly accurate, displacement determinations using relatively simplified calculations and relatively few correlation function value points. ~~Thus, such a displacement measuring system can track high speed displacements with high accuracy. The systems and methods are especially suitable for measuring displacement of a surface using speckle images.~~